RJ45 Network Cable Tester

Check out network cables and connectors

Design by A. J. Baur

This simple tester allows faults in ISDN and Ethernet cables using RJ45 connectors to be traced quickly and efficiently.

Many Ethernet and ISDN connection systems employ sockets and plugs called 'RJ45'. They look like a slightly wider version of the RJ11 or 'Western' connectors as found on modern telephone sets. The RJ45 connector has 8 pins, although in some cases only four or six are actually used (designation: RJ45-4/8 and RJ45-6/8 respectively). The connectors are available in screened and non-screened versions. For 10 Mbit/s and 100 Mbit/s (as well as for ISDN), the unscreened variants of the plug/socket combination is sufficient, provided the cables are of the 'twisted pair' type (unshielded twisted pair, UTP). If not, crosstalk is likely to increase the risk of data corruption on long lines. Some popular network cable types and their main characteristics are shown in the **Table**.

The connectors are based on cut/clamp technology to ensure proper contact with the network cable. First, the cable sleeve is removed. Next, the individual wires are inserted, insulation and all, in small holes in the connector. Finally, the wires are pressed firmly onto the connector parts using a special crimp tool. Because this tool is expensive and hard to get, it is not surprising to see hobbyists attempting the use of less sophisticated means to connect cables to RJ45 connectors. We've even heard of people pressing the individual contacts over the cable using a sharp object.

Fitting an RJ45 connector on to a network cable can be a very exasperating exercise, especially in a badly lit place like at the end of a cable conduit. Because it is not possible to actually see if the wires are properly connected in the plug, the only reliable way of testing a cable is to check continuity of all individual wires. Unfortunately, once installed, network cables do not lend themselves very well to testing with an ohmmeter simply because the ends are too far apart. Also, even if you

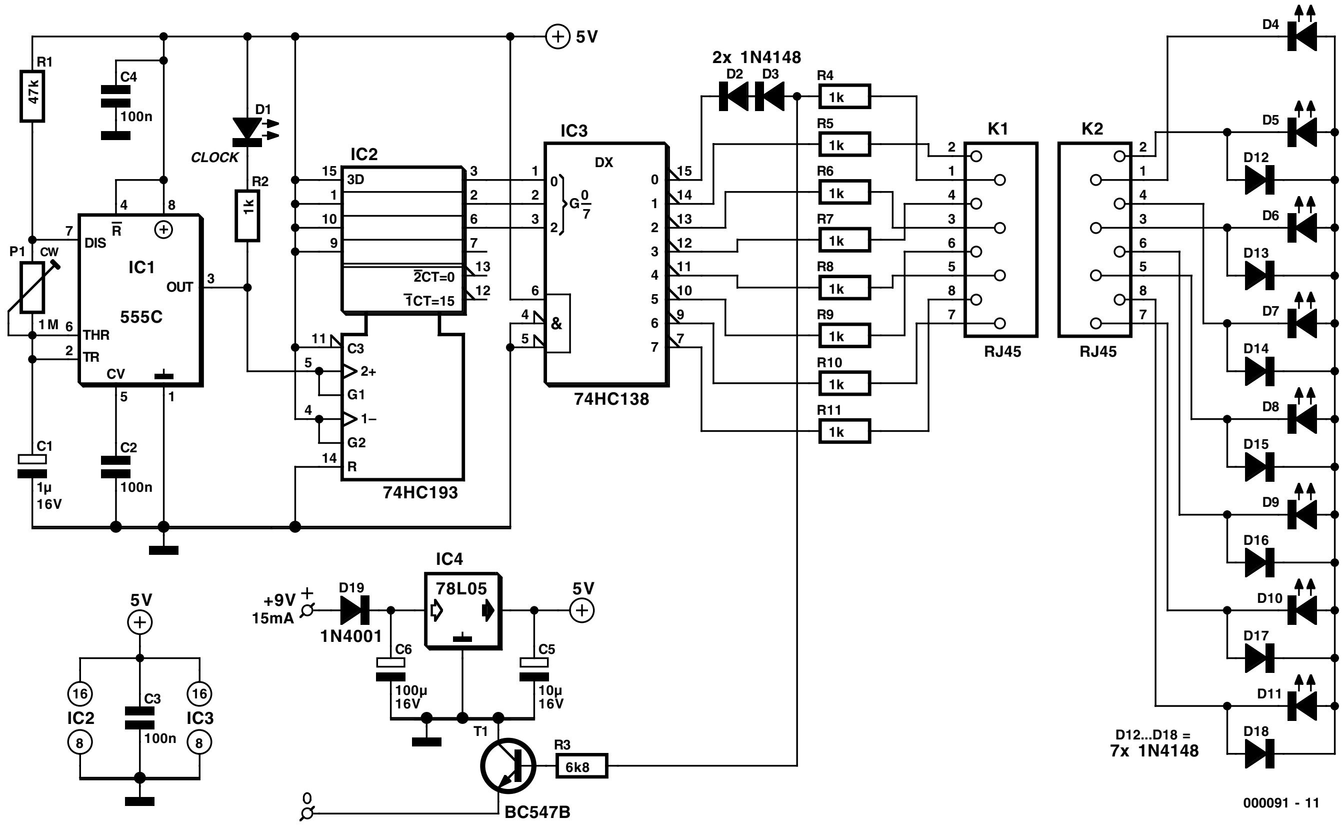

Figure 1. The two-part circuit diagram of the RJ45 Tester.

have both ends of a freshly 'pressed' RJ45 cable in front of you on a clean desktop with good lighting conditions, you'll have a hard time establishing contact between the cable wires and the meter probes.

The solution to all these problems is the RJ45 tester described in this article. The tester is actually a system consisting of a sender and a receiver box, both equipped with an RJ45 socket. All eight wires in the cable are tested in one operation, no need to remove and insert the cable under test.

The tester is realized by the deceptively simple circuit shown in **Figure 1**. The sender box consists of a CMOS timer type 555, IC1, configured as an astable multivibrator whose output frequency is adjustable between 1 Hz and about 40 Hz using preset P1. The output signal on pin 3 is first applied to a counter with BCD outputs (IC2, a 73HC193), which is wired for 'endless' counting to produce sequences 0-7 on QA (pin 2) and QC (pin 6) all the time. The code is then applied to a BCD/Decimal converter type 74HC138 (IC3), of which an output is pulled low (active) that matches the current BCD input number.

At the receiver side we find just eight LEDs whose associated series resistors R4-R11 are located on the sender board. Across each LED sits an 1N4148 diode in anti-parallel. The function of these diodes should be clear: if a current is to flow through a selected LED, the return path is not along any of the other LEDs, because they do not conduct. So, because not all wires may be available, each LED is hunted by an anti-parallel diode, except LED D4.

This is by no means an oversight on the part of the designer. Via diodes D2 and D3, a transistor is connected to pin 15 of the 74HC138 decoder. T1 acts as a switch for the power supply, obviating an all-mechanical counterpart. When the tester is not active, junction D3-R3-R4 is at ground potential, and with it, the base of T1. Because D2 and D3 prevent base current from flowing into T1, so that the circuit is held 'off'. That changes to 'on' once the LED box is connected to other end of the cable under test. This automatic power-down system makes the circuit very energy efficient.

Once the sender and receiver are connected up, the voltage on the LED common rail rises to about 4.3 V, of which about 2 V actually reach the base of T1. Incidentally, the base current flowing via D4, R4 and R3 is the cause of LED D4 lighting dimly all the time. On the other hand, D4 when activated also lights less brightly than the other LEDs because of the voltage drop on D2-R3. Fortunately, the difference between D4 being 'on' and 'off' is clear to see. When the LED is activated, it drops about 1.4 V, which is sure to keep T1 switched on.

Construction and use

Stuffing the printed circuit board shown in **Figure 2** should not cause any difficulty whatsoever. Unfortunately, the PCB shown here is not available ready-made from the Publishers.

If you make sure that all polarised parts are fitted the right way around, and the wire link next to IC4 is not overlooked, the RJ45 Tester should not take you more than an hour to finish, including fitting the sender and receiver boards in suitable plastic cases.

When using the popular 10BASE-T2 cable,

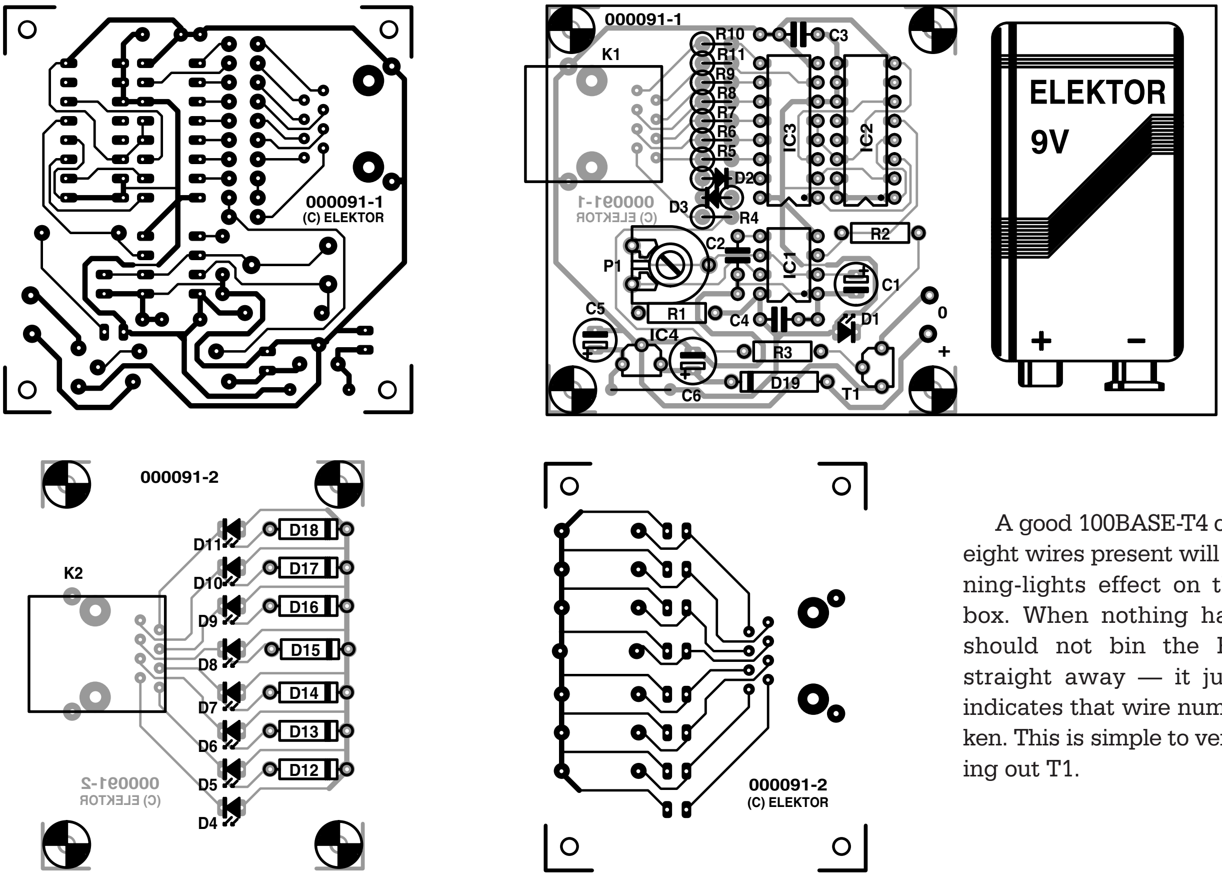

Figure 2. PCB layout designed for the RJ45 Tester (board not available ready-made).

(two twisted-pair ISDN pairs), LEDs D1, 2, 3 and 6 light in sequence. With crossed wires, the same LEDs light but the sequence is reversed (6-3-2-1). If the LED indicators light in a steady order, all cable wires are intact. When several LEDs light at the same time, one or more wires are short-circuited somewhere in the cable or its connectors. Alternatively, if one LED does not light when it should, the relevant wire or connection is broken somewhere.

A good 100BASE-T4 cable with all eight wires present will cause a running-lights effect on the Receiver box. When nothing happens, you should not bin the RJ45 Tester straight away — it just faithfully indicates that wire number 1 is broken. This is simple to verify by shorting out T1.

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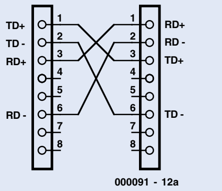
Network Cable Types

Designation	Application	No. of Wires
10BASE-T2	*10 Mbits/s Ethernet:*	*2 pairs Cat. 3 (or better), UTP*
10BASE-T Crossover	*10 Mbits/s Ethernet:*	*2 pairs Cat. 3 (or better), UTP, crossed*
100BASE-T2	*100 Mbits/s Ethernet:*	*2 pairs Cat. 3 (or better), UTP*
100BASE-T Crossover	*100 Mbits/s Ethernet:*	*2 pairs Cat. 3 (or better), UTP, crossed*
100 BASE-T4	*100 Mbits/s Ethernet:*	*4 pairs Cat. 3 (or better), UTP*
100BASE-TX	*100 Mbits/s Ethernet:*	*2 pairs Cat. 5, UTP*

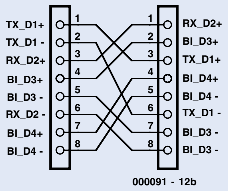
Pin allocation

	10BASE T2	*100BASE T4*
Pin 1	*TD+*	*TX_D1+*
Pin 2	*TD-*	*TX_D1-*
Pin 3	*RD+*	*RX_D2+*
Pin 4	*nc*	*BI_D3+*
Pin 5	*nc*	*BI_D3-*
Pin 6	*RD-*	*RX_D2-*
Pin 7	*nc*	*BI_D4+*
Pin 8	*nc*	*BI_D4-*

10BASE T



100BASE T



COMPONENTS LIST

Resistors:
R1 = 47kΩ
R2,R4-R11 = 1kΩ
R3 = 6kΩ8
P1 = 1k preset H

Capacitors:
C1 = 1µF 16V radial
C2,C3,C4 = 100nF
C5 = 10µF 16V radial
C6 = 100µF 16V radial

Semiconductors:
D1,D4-D11 = LED, red, high efficiency
D2,D3,D12-D18 = 1N4148
D19 = 1N4001
T1 = BC547B
IC1 = 555C
IC2 = 74HC193
IC3 = 74HC138
IC4 = 78L05

Miscellaneous:
K1,K2 = 8-way RJ45 socket, PCB mount (Farnell # 257-102)
2 Solder pins
Plastic case with battery compartment, size approx. 101x60x26mm (Conrad Electronics # 522864)